SAT Initiative: The Ohio Valley Education Center (Marietta, OH), Warren Elementary School (Marietta, OH), and Neale Elementary School (Vienna, WV)

This document describes the analysis of air monitoring and other data collected under EPA's initiative to assess potentially elevated air toxics levels at some of our nation's schools. The document has been prepared for technical audiences (e.g., risk assessors, meteorologists) and their management. It is intended to describe the technical analysis of data collected for these schools in clear, but generally technical, terms. A summary of this analysis is presented on the page focused on these schools on EPA's website (www.epa.gov/schoolair).

I. Executive Summary

- As part of the EPA initiative to monitor specific air toxics in the outdoor air around priority schools in 22 states and 2 tribal areas, air monitoring has been conducted at the Ohio Valley Educational Service Center (Ohio Valley) and Warren Elementary School (Warren) in Marietta, Ohio, and at Neale Elementary School in Vienna, West Virginia.
- These schools were selected for monitoring based on information indicating the potential for elevated concentrations of manganese in air outside the schools due to a large nearby manganese ore processing (ferroalloy) facility, Eramet Marietta Inc. (Eramet). The information included results of previous monitoring conducted by the Ohio Environmental Protection Agency (OEPA), as well as U.S. EPA's recently completed 2002 National Air Toxics Assessment (NATA) and a USA Today analysis based on the 2005 Toxics Release Inventory.
- Another metal (lead) was identified for monitoring at two of the schools (Ohio Valley and Warren) based on EPA's 2002 NATA modeling of lead emissions from a nearby electric power generation facility.
- Air monitoring for manganese and other metals in particulate matter less than 10 microns (PM_{10}) and for lead in total suspended particles (TSP) was performed from August 17, 2009 through November 15, 2009.
- The levels of lead (TSP), a pollutant for which there are national standards for ambient air, are below the level of the national standard for protection of public health.
- The levels of manganese (PM_{10}) measured in the outdoor air at these schools indicate influence of the identified source and are substantially elevated over typical air levels as had been suggested by the information available prior to EPA's monitoring.
- Information on wind patterns on the sampling days indicates that locations closer to the identified source would have higher concentrations.
- Measured levels of manganese (PM_{10}) and associated longer-term concentration estimates at these schools indicate a potential for levels of health concern for long-term continuous exposures, most particularly in locations closer to the source than those monitored here.
- As part of an effort separate from the air monitoring initiative, a recent EPA-sponsored study investigated, but did not detect, the existence of a relationship between blood manganese levels and neurological test measurements for the Marietta adults studied.

- The identified facility, Eramet, has recently indicated they will be replacing the emission control device on one of their furnaces in early 2011. When this control replacement is completed, it should reduce emissions of particulate matter, resulting in reductions in manganese emissions.
- EPA will be evaluating available emissions control technologies and reviewing the maximum achievable control technology that may be appropriate to require at the Eramet facility as part of our review of the National Emissions Standards for Hazardous Air Pollutants Maximum Achievable Control Technology standard for ferroalloys production. Coincident with this review of control technologies, which is now underway, EPA will also be considering the need for additional risk-based standards at this type of facility (ferroalloys).
- EPA recommends and will support additional monitoring for manganese (PM_{10}) in a location close to the Eramet facility to better characterize any reductions in emissions based on actions taken at the facility.
- The OEPA will continue to oversee industrial facilities in the area through air permits and other programs. The OEPA continues to monitor metals in TSP at two locations in the area.

II. Background on this Initiative

As part of an EPA initiative to implement Administrator Lisa Jackson's commitment to assess potentially elevated air toxics levels at some of our nation's schools, EPA and state and local air pollution control agencies are monitoring specific (key) air toxics in the outdoor air around priority schools in 22 states and 2 tribal areas (http://www.epa.gov/schoolair/schools.html).

- The schools selected for monitoring include some schools that are near large industries that are sources of air toxics, and some schools that are in urban areas, where emissions of air toxics come from a mix of large and small industries, cars, trucks, buses and other sources.
- EPA selected schools based on information available to us about air pollution in the vicinity of the school, including results of the 2002 National-Scale Air Toxics Assessment (NATA), results from a 2008 USA Today analysis on air toxics at schools, and information from state and local air agencies. The analysis by USA Today involved use of EPA's Risk Screening Environmental Indicators tool and Toxics Release Inventory (TRI) for 2005.
  - Available information had raised some questions about air quality near these schools that EPA concluded merited investigation. In many cases, the information indicated that estimated long-term average concentrations of one or more air toxics were above the upper end of the range that EPA generally considers as acceptable (e.g., above 1-in-10,000 cancer risk for carcinogens).

- Monitors are placed at each school for approximately 60 days, and take air samples on at least 10 different days during that time. The samples are analyzed for specific air toxics identified for monitoring at the school (i.e., key pollutants).[1]
- These monitoring results and other information collected at each school during this initiative allow us to:
  - assess specific air toxics levels occurring at these sites and associated estimates of longer-term concentrations in light of health risk-based criteria for long-term exposures,
  - better understand, in many cases, potential contributions from nearby sources to key air toxics concentrations at the schools,
  - consider what next steps might be appropriate to better understand and address air toxics at the school, and
  - improve the information and methods we will use in the future (e.g., NATA) for estimating air toxics concentrations in communities across the U.S.

Assessment of air quality under this initiative is specific to the air toxics identified for monitoring at each school. This initiative is being implemented in addition to ongoing state, local and national air quality monitoring and assessment activities, including those focused on criteria pollutants (e.g., ozone and particulate matter) or existing, more extensive, air toxics programs.

Several technical documents prepared for this project provide further details on aspects of monitoring and data interpretation and are available on the EPA website (e.g., www.epa.gov/schoolair/techinfo.html). The full titles of these documents are provided here:

- *School Air Toxics Ambient Monitoring Plan*
- *Quality Assurance Project Plan For the EPA School Air Toxics Monitoring Program*
- *Schools Air Toxics Monitoring Activity (2009), Uses of Health Effects Information in Evaluating Sample Results*

Information on health effects of air toxics being monitored[2] and educational materials describing risk concepts[3] are also available from EPA's website.

III. Basis for Selecting these Schools and the Air Monitoring Conducted

This document describes air monitoring data collected at three schools: Ohio Valley Educational Service Center (Ohio Valley) and Warren Elementary School (Warren) in Marietta, Ohio, and at Neale Elementary School (Neale) in Vienna, West Virginia. These schools were selected for monitoring in consultation with two state air agencies, Ohio Environmental Protection Agency (OEPA) and West Virginia Department of Environmental Protection (WVDEP). The basis for school selection included monitoring and modeling information.

[1] In analyzing air samples for these key pollutants, samples are also analyzed for some additional pollutants that are routinely included in the analytical methods for the key pollutants.
[2] For example, http://www.epa.gov/schoolair/pollutants.html, http://www.epa.gov/ttn/fera/risk_atoxic.html.
[3] For example, http://www.epa.gov/ttn/atw/3_90_022.html, http://www.epa.gov/ttn/atw/3_90_024.html.

The monitoring information included ambient air monitoring data previously collected by OEPA, which identified elevated levels of manganese in the ambient air in Marietta, Ohio and Vienna, West Virginia near an industrial complex in which Eramet resides (labeled as A in Figure 1) and several other nearby smaller sources of manganese. Eramet is an electrometallurgical manufacturing facility that produces manganese products, including ferroalloys, used by the steel and aluminum industries. OEPA has conducted monitoring at several locations near this industrial complex in both Ohio and West Virginia at various times beginning in 2000 and continuing into the present (described in more detail in section V below).

The modeling information included estimates from EPA's 2002 NATA and a USA Today analysis based on the 2005 Toxics Release Inventory (TRI) that indicated the potential for elevated manganese concentrations in the area associated with emissions from the ferroalloy facility, Eramet. Warren and Ohio Valley were both identified in the top 25 on the USA Today list due to the 2005 Toxics Release Inventory estimates of manganese from Eramet (http://content.usatoday.com/news/nation/environment/smokestack/index). Additionally, EPA's 2002 NATA analysis also indicated the potential for elevated ambient concentrations of lead at Ohio Valley and Warren due to lead emission estimates in the 2002 National Emissions Inventory for a nearby electric power generation facility (labeled as B in Figure 1).

Monitoring for EPA's school air toxics initiative commenced at these schools on August 17, 2009, and continued through November 15, 2009. To the extent practicable, sampling dates were coordinated between OEPA and WVDEP. During this period between 12 and 16 samples of airborne particles were collected using a PM_{10} sampler (Ohio Valley, 12; Warren, 13; and Neale, 16).[4] These samples were analyzed for manganese (the key pollutant at all three schools), lead (a key pollutant at Warren and Ohio Valley) and for a small standardized set of additional metals that are routinely included in the analytical methods for the key pollutants (http://www.epa.gov/schoolair/techinfo.html).[5] Additionally, at each of the two schools for which lead was identified as a key pollutant (Warren and Ohio Valley), 13 TSP samples were collected and analyzed for lead.

IV. Monitoring Results and Analysis

A. Background for the SAT Analysis

The majority of schools being monitored in this initiative were selected based on modeling analyses that indicated the potential for annual average air concentrations of some specific (key) hazardous air pollutants (HAPs or air toxics)[6] to be of particular concern based on approaches that are commonly used in the air toxics program for considering potential for long-term risk.

[4] In general this sampler collects airborne particles with a diameter of 10 microns or smaller, more of which would be considered to be in the respirable range on which the health-based comparison level for manganese is based.
[5] OEPA and WVDEP staff operated the monitors and sent the sample filters to the analytical laboratory under contract to EPA.
[6] The term hazardous air pollutants (commonly called HAPs or air toxics) refers to pollutants identified in section 112(b) of the Clean Air Act which are the focus of regulatory actions involving stationary sources described by CAA section 112 and are distinguished from the six pollutants for which criteria and national ambient air quality standards (NAAQS) are developed as described in section 108. One of the criteria pollutants, lead, is also represented, as lead compounds, on the HAP list.

For example, such analyses suggested annual average concentrations of some air toxics were greater than long-term risk-based concentrations associated with an additional cancer risk greater than 10-in-10,000 or a hazard index on the order of or above 10. To make projections of air concentrations, the modeling analyses combined estimates of air toxics emissions from industrial, motor vehicle and other sources, with past measurements of winds, and other meteorological factors that can influence air concentrations, from a weather station in the general area. In some cases, the weather station was very close (within a few miles), but in other cases, it was much further away (e.g., up to 60 miles), which may contribute to quite different conditions being modeled than actually exist at the school. The modeling analyses are intended to be used to prioritize locations for further investigation.

The primary objective of this initiative is to investigate - through monitoring air concentrations of key air toxics at each school over a 2-3 month period - whether levels measured and associated longer-term concentration estimates are of a magnitude, in light of health risk-based criteria, for which follow-up activities may need to be considered. To evaluate the monitoring results consistent with this objective, we developed health risk-based air concentrations (the long-term comparison levels summarized in Appendix A) for the monitored air toxics using established EPA methodology and practices for health risk assessment[7] and, in the case of cancer risk, consistent with the implied level of risk considered in identifying schools for monitoring. Consistent with the long-term or chronic focus of the modeling analyses, based on which these schools were selected for monitoring, we have analyzed the full record of concentrations of air toxics measured at these schools, using routine statistical tools, to derive a 95 percent confidence interval[8] for the estimate of the longer-term average concentration of each of these pollutants. In this project, we are reporting all actual numerical values for pollutant concentrations including any values below method detection limit (MDL).[9] Additionally, a value of 0.0 is used when a measured pollutant has no value detected (ND). The projected range for the longer-term concentration estimate for each chemical (most particularly the upper end of the range) is compared to the long-term comparison levels. These long-term comparison levels conservatively presume continuous (all-day, all-year) exposure over a lifetime. The analysis of the air concentrations also includes a consideration of the potential for cumulative multiple

[7] While this EPA initiative will rely on EPA methodology, practices, assessments and risk policy considerations, we recognize that individual state methods, practices and policies may differ and subsequent analyses of the monitoring data by state agencies may draw additional or varying conclusions.

[8] When data are available for only a portion of the period of interest (e.g., samples not collected on every day during this period), statisticians commonly calculate the 95% confidence interval around the dataset mean (or average) in order to have a conservative idea of how high or low the "true" mean may be. More specifically, this interval is the range in which the mean for the complete period of interest is expected to fall 95% of the time (95% probability is commonly used by statisticians). The interval includes an equal amount of quantities above and below the sample dataset mean. The interval that includes these quantities is calculated using a formula that takes into account the size of the dataset (i.e., the 'n') as well as the amount by which the individual data values vary from the dataset mean (i.e., the "standard deviation"). This calculation yields larger confidence intervals for smaller datasets as well as ones with more variable data points. For example, a dataset including {1.0, 3.0, and 5.0}, results in a mean of 3.0 and a 95% confidence interval of 3.0 +/- ~5 (or -2.0 to 8.0). For comparison purposes, a dataset including {2.5, 3 and 3.5} results in a mean of 3.0 and a 95% confidence interval of 3.0 +/- ~1.2 (or 1.8 to 4.2). The smaller variation within the data in the second set of values causes the second confidence interval to be smaller.

[9] Method detection limit (MDL) is the minimum concentration of a substance that can be measured and reported with 99% confidence that the pollutant concentration is greater than zero and is determined from the analysis of a sample in a given matrix containing the pollutant.

pollutant impacts.[10] In general, where the monitoring results indicate estimates of longer-term average concentrations that are above the comparison levels - i.e., above the cancer-based comparison levels or notably above the noncancer-based comparison levels - we will consider the need for follow-up actions such as:

- → Additional monitoring of air concentrations and/or meteorology in the area,
- → Evaluation of potentially contributing sources to help us confirm their emissions and identify what options (regulatory and otherwise) may be available to us to achieve emissions reductions, and
- → Evaluation of actions being taken or planned nationally, regionally or locally that may achieve emission and/or exposure reductions. An example of this would be actions taken to address the type of ubiquitous emissions that come from mobile sources.

We have further analyzed the dataset to describe what it indicates in light of some other criteria and information commonly used in prioritizing state, local and national air toxics program activities. State, local and national programs often develop long-term monitoring datasets in order to better characterize pollutants near particular sources. The 2-3 month dataset developed under this initiative will be helpful to those programs in setting priorities for longer term monitoring projects. The intent of this analysis is to make these 2-3 month monitoring datasets as useful as possible to state, local and national air toxics programs in their longer term efforts to improve air quality nationally. To that end, this analysis:

- → Describes the air toxics measurements in terms of potential longer-term concentrations, and, as available, compares the measurements at these schools to monitoring data from national monitoring programs.
- → Describes the meteorological data by considering conditions on sampling days as compared to those over all the days within the 2-3 month monitoring period and what conditions might be expected over the longer-term (as indicated, for example, by information from a nearby weather station).
- → Describes available information regarding activities and emissions at the nearby source(s) of interest, such as that obtained from public databases such as TRI and/or consultation with the local air pollution authority.

B. Chemical Concentrations

We developed two types of long-term health risk-related comparison levels (summarized in Appendix A below) to address our primary objective. The primary objective is to investigate through the monitoring data collected for key pollutants at these schools, whether pollutant levels measured and associated longer-term concentration estimates are elevated enough in comparison with health risk-based criteria to indicate that follow-up activities be considered. These comparison levels conservatively presume continuous (all-day, all-year) exposure over a lifetime.

[10] As this analysis of a 2-3 month monitoring dataset is not intended to be a full risk assessment, consideration of potential multiple pollutant impacts may differ among sites. For example, in instances where no individual pollutant appears to be present above its comparison level, we will also check for the presence of multiple pollutants at levels just below their respective comparison levels (giving a higher priority to such instances).

In developing or identifying these comparison levels, we have given priority to use of relevant and appropriate air standards and EPA risk assessment guidance and precedents.[11] These levels are based upon health effects information, exposure concentrations and risk estimates developed and assessed by EPA, the U.S. Agency for Toxic Substances and Disease Registry, and the California EPA. These agencies recognize the need to account for potential differences in sensitivity or susceptibility of different groups (e.g., asthmatics) or lifestages/ages (e.g., young children or the elderly) to a particular pollutant's effects so that the resulting comparison levels are relevant for these potentially sensitive groups as well as the broader population.

In addition to evaluating individual pollutants with regard to their corresponding comparison levels, we also considered the potential for cumulative impacts from multiple pollutants in cases where individual pollutant levels fall below the comparison levels but where multiple pollutant mean concentrations are within an order of magnitude of their comparison levels.

Using the analysis approach described above, we analyzed the chemical concentration data (Table 1 and Figures 2a-2b) with regard to areas of interest identified below.

Key findings drawn from the information on chemical concentrations and the considerations discussed below include:

- The air sampling data collected over the 3-month sampling period and the related longer-term concentration estimates for manganese indicate influence from a nearby source, Eramet, and are somewhat above the long-term comparison level, indicating concentrations of potential concern for continuous, long-term exposures, particularly in locations closer to the source than those monitored in this project.
- Lead measurements and longer-term concentration estimates were below the national standard for protection of public health for lead.

<u>Manganese, key pollutant:</u>

- Do the monitoring data indicate influence from a nearby source?

  → The data collected at each of the schools include many manganese (PM_{10}) concentrations that were higher than concentrations commonly observed in other locations nationally.[12] Additionally, as discussed in section IV.C below, on the majority of days on which the highest concentrations were measured, the wind information indicates portions of the average daily winds were from the direction of the source, Eramet, discussed in section III above.

- Do the monitoring data indicate elevated levels that pose long-term health concerns?

[11] This is described in detail in *Schools Air Toxics Monitoring Activity (2009), Uses of Health Effects Information in Evaluating Sample Results*.

[12] For example, more than half of the samples at each of the schools (Table 2) were higher than 75 percent of samples collected at the National Air Toxics Trends Stations (NATTS) from 2004-2008 (Appendix B). Because the NATTS are generally sited so as not to be influenced by specific nearby sources, EPA is using the 75th percentile point of concentrations at these sites as a benchmark for indicating potential influence from a source nearby to this school.

→ The monitoring data for manganese, in addition to OEPA data for other locations, indicate a potential for levels of health concern for long-term, continuous exposures, particularly in locations closer to the identified source.

- The estimates of the longer-term manganese (PM_{10}) concentration (i.e., the upper bound of the 95 percent confidence interval on the mean of the dataset) for each of the schools are somewhat above the long-term comparison level (Table 1).[13] This comparison level is a continuous exposure concentration (all day, all year, over a lifetime) associated with little risk of adverse effect; it is not an exposure concentration at which effects have been observed or are predicted to occur.[14]
- As manganese has not been found to be carcinogenic, it has no cancer-based comparison level.[15]

→ In summary, the estimate of longer-term concentration, while below longer-term exposure levels at which health effects have been documented in exposed workers, indicates a potential for levels of health concern for long-term, continuous exposure, most particularly in areas of the community closer to the source than the locations monitored in this project.

- Do the monitoring data indicate elevated levels that pose short-term health concerns?

  → We identified one sample result at Warren which was higher than the individual sample screening level.[14] A sample result above the screening level does not mean that there is a risk to children at the school. The individual sample screening level was a signal to EPA to evaluate and track that and subsequent results. Based on all the results, we did not identify concerns regarding short-term exposure for this area.

Lead (TSP), key pollutant:

- At the two schools where lead (TSP) was monitored (Ohio Valley and Warren), do the monitoring data indicate influence from a nearby source?

  → The measurements at these schools included one lead (TSP) concentration at Warren and two lead (TSP) concentrations at Ohio Valley that were slightly higher than the other measurements taken at the schools, which may indicate that those samples were collected on days where nearby sources were influencing concentrations at the schools. This is discussed further in section IV.C below.

- Do the monitoring data at the two schools where lead (TSP) was monitored (Ohio Valley and Warren) indicate elevated levels that pose long-term health concerns?

[13] The upper ends of the intervals at the three schools are generally twice the corresponding means of the monitoring data, and from three to seven times the long-term noncancer-based long-term comparison level.

[14] The comparison level for manganese is based on the RfC. Manganese concentrations at which health effects have been documented are higher than the RfC (http://www.atsdr.cdc.gov/tfacts151.html, http://www.epa.gov/ttn/atw/hlthef/manganes.html#conversion). For example, continuous, long-term exposure levels approximately 1000 times higher than the comparison level are reported to cause neurological effects in workers exposed in industrial workplaces that process metallic materials.

[15] www.epa.gov/iris

→ The monitoring levels of lead (TSP) are below the national ambient air quality standard for protection of public health for lead.

- The estimates of longer-term lead (TSP) concentrations (i.e., the upper bound of the 95 percent confidence interval on the mean of the dataset) at these two schools are substantially below the long-term comparison level (Table 1).[16] The comparison level is the level of the national ambient air quality standard.

→ In summary, the monitoring data do not indicate concentrations above the national ambient air quality standard for protection of public health.

Other Air Toxics:

- Do the monitoring data indicate elevated levels of any other air toxics (or HAPs) that pose significant long-term health concerns?

  → The monitoring data for all three schools show low levels of the other HAPs monitored, with longer-term concentration estimates for these HAPs below their long-term comparison levels (Appendix C). Additionally, each individual measurement for these pollutants is below the individual sample screening level[11] for that pollutant.

Multiple Pollutants:

- Do the data collected for the air toxics monitored indicate the potential for other monitored pollutants to be present at levels that in combination with the key pollutant levels indicate an increased potential for cumulative impacts of significant concern (e.g., that might warrant further investigation)?

  → The data collected for the key and other air toxics and the associated longer-term concentration estimates do not together pose significant concerns for cumulative health risk from these pollutants (Appendix C).[17]

C. Wind and Other Meteorological Data

At each school monitored as part of this initiative, we are collecting meteorological data, minimally for wind speed and direction, during the sampling period. Additionally, we have identified the nearest National Weather Service (NWS) station at which a longer record is available.

In reviewing these data at each school in this initiative, we are considering if these data indicate that the general pattern of winds on our sampling dates are significantly different from those

[16] The upper end of the interval is nearly one and a half times the mean of the monitoring data and less than 5% of the noncancer-based long-term comparison level. This comparison value for lead is the level of the national ambient air quality standard, which is in terms of a rolling 3-month average level of lead in total suspended particles.

[17] We note that this initiative is focused on investigation for a school-specific set of key pollutants indicated by previous analyses (and a small set of others for which measurements are obtained in the same analysis). Combined impacts of pollutants or stressors other than those monitored in this project is a broader area of consideration in other EPA activities. General information on additional air pollutants is available at http://www.epa.gov/air/airpollutants.html

occurring across the full sampling period or from those expected over the longer term. Additionally, we are noting, particularly for school sites where the measured chemical concentrations show little indication of influence from a nearby source, whether wind conditions on some portion of the sampling dates were indicative of a potential to capture contributions from the nearby "key" source in the air sample collected.

The meteorological stations at Ohio Valley, Warren, and Neale schools collected wind speed and wind direction measurements for the following time periods:

- → Ohio Valley: August 27, 2009 continuing through the sampling period (August 17, 2009-November 15, 2009) and ending on April 15, 2010;
- → Warren: August 7, 2009 continuing through the sampling period (August 17, 2009-November 3, 2009) and ending on April 19, 2010; and
- → Neale: August 6, 2009 continuing through the sampling period (August 17, 2009-November 15, 2009) and ending on January 26, 2010.

As a result, on-site data for these meteorological parameters are available for all dates of sample collection at each school and also for a period before and after the sampling period, producing a continuous record of nearly eight months at Ohio Valley and Warren and over five months at Neale. The meteorological data collected on sampling days are presented in Figure 4 and Table 2.

The nearest NWS station is at Mid-Ohio Valley Regional Airport in Parkersburg, OH. This station is approximately 5.0 miles south-southeast of Ohio Valley, 6.7 miles east-southeast of Warren, and 5.9 miles east-northeast of Neale. Measurements taken at that station include wind, temperature, and precipitation. These are presented in Table 2 and Appendix E.

Key findings drawn from this information and the considerations discussed below include:

- Both the sampling results and the on-site wind data indicate that some of the air samples were collected on days when the nearby key sources were contributing to conditions at each school location.

- While wind directions at the three schools do not appear to be similar in an hour-by-hour comparison, they do appear to be affected by the same general meteorological conditions that affect overall wind direction in the study region.

- The wind patterns at each school monitoring site across sampling dates are generally similar to those observed across the record of on-site meteorological data during the sampling period.

- Our ability to provide confident characterizations of the wind flow patterns at the monitoring sites over the long-term is somewhat limited as the wind patterns at the Mid-Ohio Valley Regional Airport NWS station are not similar to specific wind flow patterns at each school location. Additional meteorological monitoring at each school site (or near to it) during additional seasonal periods would assist in characterizing true long-term patterns.

- Although we lack long-term wind data at each individual school, the wind pattern at the NWS site during the sampling period is generally similar to the historical long-term wind flow pattern at that same NWS site. This suggests that, on a regional scale, the 3-month sampling period is generally representative of year-round wind patterns.

- What are the directions of the key sources of manganese and lead emissions in relation to each school location?

  → The nearby sources emitting the key pollutants into the air (described in section III above) lay approximately 4.1 miles southwest of Ohio Valley, 2.4 miles east-southeast to southeast of Warren, and 3.7 miles north-northeast to northeast of Neale.
  → Using the property boundaries of each facility (in lieu of information regarding the location of specific sources of manganese and lead emissions at each facility), we have identified an approximate range of wind directions to use in considering the potential influence of these facilities on air concentrations at each school.
  → This general range of wind directions, from approximately 215 to 235 degrees, is referred to here as the expected zone of source influence (ZOI) for Ohio Valley.
  → This general range of wind directions, from approximately 100 to 145 degrees, is referred to here as the expected ZOI for Warren.
  → This general range of wind directions, from approximately 11 to 55 degrees, is referred to here as the expected ZOI for Neale.

- On days the air samples were collected, how often did wind come from direction of the key sources and is there any relationship in wind patterns between the three schools?
  - → For Ohio Valley, there were six out of 15 sampling days in which a portion of the winds were from the expected ZOI (Figures 3a-3b, Table 2).
  - → For Warren, there were nine out of 14 sampling days in which a portion of the winds were from the expected ZOI (Figures 3a-3b, Table 2).
  - → For Neale, there were ten out of 16 sampling days in which a portion of the winds were from the expected ZOI (Figures 3a-3b, Table 2).
  - → While wind directions at the three schools do not appear to be similar in an hour-by-hour comparison, the changes in wind direction (clockwise vs. counterclockwise) from one hour to the next are similar among the three schools at a greater frequency than would be expected if the wind directions were truly independent of each other. This suggests that wind directions at the three schools are affected by the same general meteorological conditions that affect overall wind direction in the study region.

- How do wind patterns on the air monitoring days at each school compare to those across the complete monitoring period and what might be expected over the longer term at each school location?
  - → For each school, wind patterns across the air monitoring days appear to be generally similar to those observed over the record of their on-site meteorological data during the sampling periods.
  - → We note that wind patterns at the nearest NWS station (at Mid-Ohio Valley Regional Airport) during the monitoring periods are very similar to those recorded at the NWS station over the long-term (2002-2007 period; Appendix E), supporting the idea that regional meteorological patterns during the monitoring period were consistent with long-term patterns. However, there is some uncertainty as to whether this would also be the case at each school location as the general wind patterns at the Mid-Ohio Valley Regional Airport NWS station appear to differ from those at each school as discussed in bullets below.

- How do wind patterns at each school compare to those at the Mid-Ohio Valley Regional Airport station, particularly with regard to prevalent wind directions and the direction of the key sources?
  - → While wind data are not available at each school over the longer term, we note that wind patterns at the nearest NWS station (at Mid-Ohio Valley Regional Airport) during the monitoring period are not similar to the on-site wind patterns of each school; additionally, the on-site wind patterns at each school are not similar to those recorded at the NWS station over the long-term (2002-2007 period; Appendix E).
  - → During the sampling period for which data are available both at a school site and at the reference NWS station (approximately three months), prevalent wind direction changes react to meteorological influences in generally the same way at the three schools. The windroses for the three sites during the sampling period (Figure 4 and Appendix E) show differences in wind flow patterns, most likely resulting from nearby terrain.

- Are there other meteorological patterns that may influence the measured concentrations at each school monitoring site?
  → No, we did not observe other meteorological patterns that may influence the measured concentrations at the school monitoring sites.

V. Other Air Toxics Air Monitoring in This Community

As mentioned in section III, OEPA has been monitoring metals, including manganese (TSP) at several locations within 1 to 4.4 miles from the key source of concern since 2000 (Figure 5). OEPA has monitored for the longest period of time at two sites: Washington County Career Center (WCCC), 4.4 miles north-northeast of the source (since 2000) and Blue Knob Road, 0.80 miles west-northwest of the source (since 2004); however, OEPA considers data from Blue Knob Road to be of questionable quality due to tampering with the instrument. Three additional sites were added in 2007: The Ohio Valley Educational Service Center (4.1 miles northeast of source and also location of one EPA monitor); Boaz Wastewater Treatment Plant (directly across Ohio River from the source); and Neale Elementary School (3.7 miles southwest of the source which is also the location of one EPA monitor for this initiative). OEPA continues to monitor for metals (TSP) at two locations: WCCC and Ohio Valley.

Annual averages for sampling results for manganese (TSP) at all of the OEPA ambient monitoring sites in Ohio and West Virginia are provided in the following table. For the three sites included in the SAT initiative, the mean of manganese (PM_{10}) data collected during the SAT three month monitoring period is also provided. Locations for all of these sites are shown in Figure 5.

Ambient Sampling Monitors Marietta, OH		**Manganese (TSP) Data –ATSDR**					**Manganese (PM_{10}) Data SAT (2009) (Aug-Nov) ($\mu g/m^3$)**
		Annual Average ($\mu g/m^3$)					
Site Name and Agency	*Direction/ Distance to Eramet facility*	**2003**	**2004**	**2005**	**2006**	**Apr 2007-Mar 2008 ($\mu g/m^3$)**	
WCCC (OEPA1)	N-NE / 4.4mi	0.214	0.140	0.092		0.075	
Ohio Valley (OEPA2 and EPA)	NE / 4.1 mi					0.086	0.108
Blue Knob (OEPA3)	W-NW / 0.8 mi			0.420			
Boaz (OEPA4)	E / 1.4 mi					0.15	
Neale (OEPA5 and EPA)	SW / 3.7 mi					0.16	0.075
Warren (EPA)	NW / 2.4 mi						0.146

The TSP samplers used by OEPA capture airborne particles of sizes ranging from about 0.1 microns up to about 25 to 50 microns, which includes particles that can be inhaled (generally of sizes ranging up to about 10 microns). It includes the size range sometimes termed "respirable" (generally of sizes ranging up to about 3 to 4 microns), as well as larger particles that fall onto surfaces with which people may come into contact.

On July 1, 2009, the Agency for Toxic Substances and Disease Registry (ATSDR) and OEPA released the fourth health consultation for this area, which presented an analysis of the ambient

air monitoring data OEPA collected from April 2007 through March 2008. [18] These analyses indicate that the annual average concentrations of manganese in TSP at the four OEPA locations sampled in 2007-08 were somewhat higher than the EPA and ATSDR health-based chronic comparison levels (for respirable manganese), with the Neale Elementary School site recording the highest levels.[19,20] In addition, EPA's National Enforcement Investigations Center (NEIC) Lab was asked to perform a fingerprinting analysis on filters from the five area sampling locations by evaluating the elemental abundances (percentages of manganese, chromium, lead, and zinc) and particle similarities from each filter and then comparing that information with the samples taken at Eramet and two other facilities. An evaluation of the data collected pointed to one single large source of manganese in the Marietta area.[21]

VI. Health Studies in this Community

In July 2009, San Francisco State University received a Regional Applied Research Effort grant from EPA to conduct a health study of adults in Marietta, Ohio. In the health study, Mount Vernon, Ohio was selected as a comparison city because it is nearly identical demographically, but without the industrial activity and manganese emissions. The study results presented in June 2010 indicate that blood, neurological assessments and neuropsychological test results of Marietta and Mt. Vernon residents did not differ significantly, are within the average range of the general population, and did not indicate a relationship between blood manganese levels and neurological test measurements for the study subjects.
http://online.sfsu.edu/~mnstudy/study.html.

VII. Key Source Information

- Was the source of manganese operating as usual during the monitoring period?
  - Eramet is subject to the National Emissions Standards for Hazardous Air Pollutants (NESHAP) Maximum Achievable Control Technology (MACT) for the Ferroalloys Production source category and was the only source covered when the MACT standard was developed. Since then several other sources have become subject to the

[18] This most recent analysis by ATSDR is available at*:*
http://www.atsdr.cdc.gov/HAC/pha/marietta3/ATSDRMariettaHealthConsultationIII2009Final.pdf. Other ATSDR analyses are available at: http://www.atsdr.cdc.gov/sites/washington_marietta/index.html.

[19] The EPA comparison level considered by ATSDR is the same level used here, the EPA reference concentration or RfC (http://www.epa.gov/ncea/iris/subst/0373.htm). The ATSDR comparison level used was the ATSDR minimal risk level (MRL). Although ATSDR has published a draft revision to the MRL for comment, given its lack of final status, the comparison level used in ATSDR's analysis was the previously established level. The RfC and MRL are for inhalation exposure to manganese and consequently are based on manganese particles in the size range described as respirable, which is generally considered to be somewhat smaller than 10 microns in diameter. Manganese concentrations at which health effects have been documented are higher than the RfC (http://www.atsdr.cdc.gov/tfacts151.html, http://www.epa.gov/ttn/atw/hlthef/manganes.html#conversion).

[20] ATSDR's analysis, which included other metals measured in the OEPA samples, concluded that manganese is the only metal of health-related concern in the Marietta area for ambient air exposure.

[21] US EPA. 2008. Laser Ablation and Inductively Coupled Plasma Mass Spectrometry Analysis of Glass Fiber Filters Collected at Multiple Locations in the Marietta, Ohio Area form April to October 2007. National Enforcement Investigations Center, Washington DC. Report number VP0591E04.

MACT standard but all have more limited production. The facility has a CAA Title V operating permit issued by OEPA that includes operating requirements.[22]
  - All three furnaces at the source were in operation at the time of this sampling project. Several other ancillary operations were idled during the sampling period, but those operations are not sources of manganese. During the sampling period the facility was operating at about 70% of what operations had averaged over the last 5 years.
  - The most recently available manganese emissions data for this source (2008 TRI) are slightly lower than those relied upon in previous modeling for this area (2005 TRI). According to the 2008 TRI the facility emits 119.5 tons per year of manganese. Of that total, stack emissions accounted for 51.4 tons, and fugitive emissions accounted for 68.1 tons.

- Was the source of lead operating as usual during the monitoring period?
  - The nearby source of lead (TSP) (described in section III above) has an operating permit issued by OEPA that includes operating requirements.
  - The nearby coal-fired electric power generating facility was operating at normal capacity during the sampling period. This facility is slated to close in December 2012.
  - The most recently available lead emissions estimates for this source (2008 TRI) are much lower than those used in previous modeling analyses for this area (e.g. 2002 NATA and 2005 TRI).

VIII. Integrated Summary and Next Steps

A. Summary of Key Findings

1. What are the key HAPs for each school?
   → Manganese is the key HAP for all three schools, identified based on their close proximity to Eramet, an electrometallurgical manufacturing facility that produces manganese products, including ferroalloys, used by the steel and aluminum industries. The monitoring data collected confirm elevated airborne levels of manganese (PM_{10}) which, in conjunction with wind information, indicate influences of this source on airborne manganese (PM_{10}) concentrations at the three monitored schools.
   → Lead (TSP) is a key HAP for two of the schools (Warren and Ohio Valley) based on their close proximity to a nearby electric power generation facility.

2. Do the data collected at each school indicate a level of concern, as implied by information that led to identifying the schools for monitoring?
   → The levels measured and associated longer-term concentration estimates for manganese (PM_{10}) indicate the potential for levels of health concern for long-term continuous exposures, particularly at locations closer to the source than those

[22] Operating permits, which are issued to air pollution sources under the Clean Air Act, are described at: http://www.epa.gov/air/oaqps/permits/

monitored here. The data collected here for manganese (PM_{10}) are consistent with previous monitoring for manganese (TSP) performed by OEPA in the area. These data are also consistent with OEPA conclusions regarding the influence of Eramet on airborne manganese levels at this location.

→ Additionally, levels of lead (TSP), a pollutant for which there are national standards for ambient air, are below the level of the national standard for protection of public health.

3. Are there indications, e.g., from the meteorological or other data, that the sample set may not be indicative of longer-term air concentrations? Would we expect higher (or lower) concentrations at other times of year?

   → The data we have collected appear to reflect air concentrations during the entire monitoring period, with no indications from the on-site meteorological data that the sampling day conditions were inconsistent with conditions overall during this period.

   → Among the data collected for these sites, we have none that would indicate generally higher (or lower) concentrations during other times of year. The wind flow patterns at the nearest NWS station during the sampling period appear to be representative of those recorded at the NWS station over the long-term (2002-2007 period; Appendix E). However, the lack of long-term meteorological data at each school location and our finding that the wind patterns from the nearest NWS station differ from those at each school, limit somewhat our ability to confidently predict longer-term wind patterns at each school (which might provide further evidence relevant to concentrations during other times).

B. Next Steps for Key Pollutants

1. EPA will be evaluating available emissions control technologies and reviewing the maximum achievable control technology that may be appropriate to require at the Eramet. facility as part of our review of the NESHAP MACT standard for ferroalloys production. Coincident with this review of control technologies, which is now underway, EPA will also be considering the need for additional risk-based standards at this type of facility (ferroalloys).

2. EPA recommends and will support additional monitoring for manganese (PM_{10}) in a location close to the Eramet facility to better characterize any reductions in emissions based on actions taken at the facility.

3. The OEPA will continue to oversee industrial facilities in the area through air permits and other programs. The OEPA continues to monitor metals in TSP at two locations in the area.

IX. Figures and Tables

A. Tables

1. Marietta, Ohio Area Schools – Key Pollutant Analysis.
2. Marietta, Ohio Area Schools Key Pollutant Concentrations and Meteorological Data.

B. Figures

1. Marietta, Ohio Schools, Potential Sources of Interest (A, B), and Wind Information for Sampling Period.

2a. Marietta, Ohio Area Schools – Key Pollutant (Manganese (PM_{10})) Analysis.

2b. Marietta, Ohio Area – Key Pollutant (Lead (TSP)) Analysis.

3a. Marietta, Ohio Area – Manganese (PM_{10}) Concentration and Wind Information.

3b. Marietta, Ohio Area Schools – Lead (TSP) Concentration and Wind Information.

4. Marietta, Ohio Area Schools – Wind Information.
5. Marietta, Ohio Schools, Eramet Marietta, Inc (A), and Ohio EPA Monitoring Sites.

X. Appendices

A. Summary Description of Long-term Comparison Levels.

B. National Air Toxics Trends Stations Measurements (2004-2008).

C. Analysis of Other (non-key) Air Toxics Monitored at the Schools and Multiple-pollutant Considerations.

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E. Windrose for Mid-Ohio Valley Regional Airport NWS Station.

F. Neale Elementary School and Sources of Interest (A, B).

G. The Ohio Valley Educational Service Center and Sources of Interest (A, B).

H. Warren Elementary School and Sources of Interest (A, B).

Appendix A. Summary Description of Long-term Comparison Levels

In addressing the primary objective identified above, to investigate through the monitoring data collected for key pollutants at the schools whether levels are of a magnitude, in light of health risk-based criteria, to indicate that follow-up activities be considered, we developed two types of long-term health risk-related comparison levels. These two types of levels are summarized below.[23]

Cancer-based Comparison Levels:

- For air toxics where applicable, we developed cancer risk-based comparison levels to help us consider whether the monitoring data collected at the schools indicate the potential for concentrations to pose incremental cancer risk above the range that EPA generally considers acceptable in regulatory decision-making to someone exposed to those concentrations continuously (24 hours a day, 7 days a week) over an entire lifetime.[24] This general range is from 1 to 100 in a million.
- Air toxics with long-term mean concentrations below one one-hundredth of this comparison level would be below a comparably developed level for 1-in-a-million risk (which is the lower bound of EPA's traditional acceptable risk range). Such pollutants, with long-term mean concentrations below the Agency's traditional acceptable risk range, are generally considered to pose negligible risk.
- Air toxics with long-term mean concentrations above the acceptable risk range would generally be a priority for follow-up activities. In this evaluation, we compare the upper 95% confidence limit on the mean concentration to the comparison level. Pollutants for which this upper limit falls above the comparison level are fully discussed in the schools monitoring report and may be considered a priority for potential follow-up activities in light of the full set of information available for each site.
- Situations where the summary statistics for a pollutant are below the cancer-based comparison level but above 1% of that level are fully discussed in Appendix C.

[23] These comparison levels are described in more detail *Schools Air Toxics Monitoring Activity (2009), Uses of Health Effects Information in Evaluating Sample Results*.

[24] While no one would be exposed at a school for 24 hours a day, every day for an entire lifetime, we chose this worst-case exposure period as a simplification for the basis of the comparison level in recognition of other uncertainties in the analysis. Use of continuous lifetime exposure yields a lower, more conservative, comparison level than would use of a characterization more specific to the school population (e.g., 5 days a week, 8-10 hours a day for a limited number of years).

Noncancer-based Comparison Levels:

- To consider concentrations of air toxics other than lead (for which we have a national ambient air quality standard) with regard to potential for health effects other than cancer, we derived noncancer-based comparison levels using EPA chronic reference concentrations (or similar values). A chronic reference concentration (RfC) is an estimate of a long-term continuous exposure concentration (24 hours a day, every day) without appreciable risk of adverse effect over a lifetime.[25] This differs from the cancer risk-based comparison level in that it represents a concentration without appreciable risk *vs* a risk-based concentration.
- In using this comparison level in this initiative, the upper end of the 95% confidence limit on the mean is compared to the comparison level. Air toxics for which this upper confidence limit is near or below the noncancer-based comparison level (i.e., those for which longer-term average concentration estimates are below a long-term health-related reference concentration) are generally of low concern and will generally be considered a low priority for follow-up activity. Pollutants for which the 95% confidence limits extend appreciably above the noncancer-based comparison level are fully discussed below and may be considered a priority for follow-up activity if indicated in light of the full set of information available for the pollutant and the site.
- For lead, we set the noncancer-based comparison level equal to the level of the recently revised national ambient air quality standard (NAAQS). It is important to note that the NAAQS for lead is a 3-month rolling average of lead in total suspended particles. Mean levels for the monitoring data collected in this initiative that indicate the potential for a 3-month average above the level of the standard will be considered a priority for consideration of follow-up actions such as siting of a NAAQS monitor in the area.

In developing or identifying these comparison levels, we have given priority to use of relevant and appropriate air standards and EPA risk assessment guidance and precedents. These levels are based upon health effects information, exposure concentrations and risk estimates developed and assessed by EPA, the U.S. Agency for Toxic Substances and Disease Registry, and the California EPA. These agencies recognize the need to account for potential differences in sensitivity or susceptibility of different groups (e.g., asthmatics) or lifestages/ages (e.g., young children or the elderly) to a particular pollutant's effects so that the resulting comparison levels are relevant for these potentially sensitive groups as well as the broader population.

[25] "EPA defines the RfC as "an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. It can be derived from a NOAEL, LOAEL, or benchmark concentration, with uncertainty factors generally applied to reflect limitations of the data used. Generally used in EPA's noncancer health assessments." http://www.epa.gov/ncea/iris/help_gloss.htm#r

Appendix C. Analysis of Other (non-key) Air Toxics Monitored at the Schools and Multiple-pollutant Considerations.

At each school, monitoring has been targeted to get information on a limited set of key hazardous air pollutants (HAPs).[26] These pollutants are the primary focus of the monitoring activities at each school and a priority for us based on our emissions, modeling and other information. In analyzing air samples for these key pollutants, we have also obtained results for some other pollutants that are routinely included with the same test method. Our consideration of the data collected for these additional HAPs is described in the first section below. In addition to evaluating monitoring results for individual pollutants, we also considered the potential for cumulative impacts from multiple pollutants as described in the second section below (see Table C-1).

Other Air Toxics (HAPs):

- Do the monitoring data indicate elevated levels of any other air toxics or hazardous air pollutant (HAPs) that pose significant long-term health concerns?

  → Longer-term concentration estimates for the other HAPs monitored are below their long-term comparison levels.

  → Further, for pollutants with cancer-based comparison levels, longer-term concentration estimates for all but two of these (chromium at all three schools and arsenic at Ohio Valley) are more than tenfold lower and all but three (chromium and arsenic at all three schools and cadmium at Ohio Valley) are more than 100-fold lower.[27]

  → Additionally each individual measurement for these pollutants is below the individual sample (short-term) screening level developed for considering potential short-term exposures for that pollutant.[28]

Additional Information on Three HAPs:

- The first of the three HAPs mentioned above is chromium. The comparison values for chromium are conservatively based on the most toxic form of chromium (hexavalent chromium, Cr^{+6}) which is only a fraction of the chromium in the ambient air. Nonetheless, the longer-term concentration estimate for chromium (PM_{10}) is below even these very restrictive comparison values. For all three schools, the mean and 95 percent

[26] Section 112(b) of the Clean Air Act identifies 189 hazardous air pollutants, three of which have subsequently been removed from this list. These pollutants are the focus of regulatory actions involving stationary sources described by CAA section 112 and are distinguished from the six pollutants for which criteria and national ambient air quality standards (NAAQS) are developed as described in section 108. One of the criteria pollutants, lead, is also represented, as lead compounds, on the HAP list.

[27] For pollutants with cancer-based comparison levels, this would indicate longer-term estimates below continuous (24 hours a day, 7 days a week) lifetime exposure concentrations associated with 10^{-5} and 10^{-6} excess cancer risk, respectively.

[28] The individual sample screening levels and their use is summarized on the web site and described in detail in *Schools Air Toxics Monitoring Activity (2009), Uses of Health Effects Information in Evaluating Sample Results.*

upper bound on the mean for chromium (PM_{10}) are approximately 25-37% of the cancer-based comparison level. As Cr^{+6} is commonly only a small fraction of chromium (PM_{10}), [29] however, the levels of Cr^{+6} in these samples would be expected to be appreciably lower than this. A review of information available at other sites nationally shows that the mean concentration of chromium (PM_{10}) at each school is between the 50th and 75th percentile of samples collected from 2004 to 2008 (the most recently compiled period) at the NATTS (Appendix B).

- The second of the three HAPs mentioned above is arsenic. For all three schools, the mean and 95 percent upper bound on the mean for arsenic (PM_{10}) are approximately 3-14% of the cancer-based comparison level. Additionally, a review of information available at other sites nationally shows that the mean concentration of arsenic (PM_{10}) at Neale and Ohio Valley is between the 75th and 95th percentile of samples collected from 2004 to 2008 (the most recently compiled period) at the NATTS (Appendix B). For Warren, the mean concentration of arsenic (PM_{10}) is between the 50th and 75th percentile of samples collected from 2004 to 2008 at the NATTS.

- The third HAP mentioned above is cadmium. For Ohio Valley, the mean and 95 percent upper bound on the mean for cadmium (PM_{10}) are approximately 1-4% of the cancer-based comparison level. The upper bound is more than two times the mean due to a single measurement being much different from the others (although still well below the individual sample screening level). A review of information available at other sites nationally shows that the mean concentration of cadmium (PM_{10}) at this site is slightly higher than the 95th percentile of samples collected from 2004 to 2008 (the most recently compiled period) at the NATTS (Appendix B).

Multiple Pollutants:

As described in the main body of the report and background materials, this initiative and the associated analyses are focused on investigation of key pollutants for each school that were identified by previous analyses. This focused design does not provide for the consideration of combined impacts of pollutants or stressors other than those monitored in this project. Broader analyses and those involving other pollutants may be the focus of other EPA activities.[30]

In our consideration of the potential for impacts from key pollutants at the monitored schools, we have also considered the potential for other monitored pollutants to be present at levels that in combination with the key pollutant levels contribute to an increased potential for cumulative impacts. This was done in cases where estimates of longer-term concentrations for any non-key HAPs are within an order of magnitude of their comparison levels even if these pollutant levels fall below the comparison levels. This analysis is summarized below.

- Do the data collected for the air toxics monitored indicate the potential for other monitored pollutants to be present at levels that in combination with the key pollutant

[29] Data in EPA's Air Quality System for locations that are not near a facility emitting hexavalent chromium indicate hexavelent chromium concentrations to comprise less than approximately 10% of total chromium concentrations.
[30] General information on additional air pollutants is available at http://www.epa.gov/air/airpollutants.html.

levels indicate an increased potential for cumulative impacts of significant concern (e.g., that might warrant further investigation)?

→ The data collected for the key and other air toxics and the associated longer-term concentration estimates do not together pose significant concerns for cumulative health risk from these pollutants.

- Aside from manganese, the key pollutant at all three schools, the only other HAPs monitored whose average concentration are more than ten percent of their lowest comparison level are chromium and arsenic. Hexavalent chromium and arsenic pose different types of risks and act on different targets in the body than does manganese, reducing the potential for a cumulative impact. The comparison level for manganese is based on noncarcinogenic effects on the nervous system, whereas the lowest comparison level for hexavalent chromium is based on carcinogenic risk to the respiratory system.[31] Further, as noted above, hexavalent chromium is commonly only a small fraction of the total chromium (PM_{10}) reported. Additionally, the cancer-based comparison level for arsenic is based on risks to the respiratory system, while the noncancer-based comparison level is based on noncancer effects considering several endpoints including development. The longer-term estimate for arsenic (PM_{10}) is only about 3-21% of the arsenic comparison levels. Taken together, these considerations reduce any concerns for cumulative health risk from these pollutants.

[31] The noncancer-based comparison level for chromium is much higher than the cancer-based level and is based on risk of other effects posed to the respiratory system by hexavalent chromium in particulate form.